STORM WATER MONITORING AND BMP DEVELOPMENT STATUS REPORT

April 2006

CTSW-RT-06-167.02.01

Final Report

California Department of Transportation

Division of Environmental Analysis

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Table of Contents

Table of Contents

List of Acronyms

BMP	best management practice
CDS	continuous deflection separator
CSF	Compost StormFilter ™
cfs	cubic feet per second
DB	detention basin
DII	drain inlet insert
ESSSP	East Span Seismic Safety Project
GSRD	gross solid removal device
ISD	inclined screen device
LRD	linear radial device
MEP	maximum extent practicable
mg/L	milligrams per liter
mm	millimeter
RVTS	Roadside Vegetated Treatment Sites
RWQCB	California Regional Water Quality Control Board
SFOBB	San Francisco – Oakland Bay Bridge
SR	state route
SWMP	Statewide Storm Water Management Plan
SWRCB	State Water Resources Control Board
TMDL	total maximum daily load
TRPA	Tahoe Regional Planning Agency
WQV	water quality volume

EXECUTIVESUMMARY

This report supplements the Annual Report and documents the status of monitoring and BMP technology development. This report provides a summary of the monitoring and applied studies conducted during the 2004/2005 fiscal year and those proposed for the next three years. This report fulfills select requirements of Sections 3.3 and 7.3.1 of the Department's Statewide Storm Water Management Plan (SWMP) and Section K2 of the Department's statewide NPDES storm water permit.

The Department has an ongoing program to develop and monitor treatment and erosion control BMPs. Treatment technology pilot studies are designed to gather definitive cost and performance data. Successfully piloted technologies may be considered for approval and listing in the SWMP as a best management practice (BMP) to be implementated in highway projects according to SWMP guidelines. Erosion control studies follow a similar process. As the statewide characterization monitoring study has been completed, current storm water characterization studies are specialized to address specific concerns, such as the pathogens and first flush studies.

This report provides brief descriptions of each treatment technology study, erosion control study, and storm water characterization study; including a summary of the principal findings and conclusions to date. Treatment technology and erosion control performance results are only found in the reports for individual studies. These are listed within Sections 2 and 3. Three-Year Action Plans of expected deliverables and schedules are included for new or ongoing studies.

The status of the BMP development and monitoring studies during fiscal year (FY) 2004-05 is summarized in Table ES-1. The BMP development and monitoring studies are generally organized as completed, ongoing, new, or under report preparation. Studies in the report preparation phase have completed monitoring, but final documents are not yet available. Most applied studies during the 2004-05 monitoring season were ongoing. Table ES-1 notes the sections where more details for each study are located in this report.

Table ES-1. Status of the Department's Storm Water Monitoring and BMP Development Field Studies for 2004-2005

Report Section	Study Title	Study Status
2.0	**Storm Water Treatment Technology Studies**	
2.4	Alternative Media Filters	Ongoing
2.5	Bioretention	Ongoing
2.6	Chemical Treatment	Ongoing
2.7	Detention Basins	Ongoing
2.8	Drain Inlet Inserts	Ongoing
2.9	Gross Solids Removal Devices	Ongoing
2.10	Infiltration	Ongoing
2.11	Sand Filters	Ongoing
2.12	Traction Sand Traps	Ongoing
2.13	Vegetated Treatment Systems	Ongoing
		Ongoing
3.0	**Erosion Control Studies**	
3.3	Roadside Erosion Control and Management Study (formerly VEMS)	Ongoing
3.4	Soil Resource Evaluation Process	Ongoing
3.5	Use of Mycorrhizal Fungi in Erosion Control Applications	Ongoing
3.6	The Use of Amendments for Re-vegetation of Disturbed Sites with Adverse Soils	Ongoing
3.7	Piloting Soil Stabilization: Permanent	Ongoing
4.0	**Storm Water Quality Characterization Studies**	
4.2	Statewide Toxicity Testing Study	Reporting
4.3	California Toxics Rule (CTR) Characterization Study	Reporting
4.4	First Flush Characterization Study	Reporting
4.5	Pathogens Characterization Study	Ongoing
4.6	District 7 Drain Inlet Cleaning Efficacy Study (litter only)	Ongoing

The Treatment BMP Technology Report (CTSW-RT-06-167.02.02) is a companion report that catalogs fact sheets for all identified storm water treatment technologies.

This report fulfills the Department's requirement under Section K.2 of the statewide NPDES permit 99-06-DWQ, (1 Caltrans 1999) and Section 7.3.1 of the Storm Water Management Plan (SWMP) (2 Caltrans 2003) to prepare and submit annual Storm Water Characterization Monitoring Plans, 3-Year Action Plans, and Research Summary Reports, and a Monitoring Strategy Report Update and a Monitoring and Reporting Program. The relationship between the reporting requirements and this submittal are as follows:

Table 1-1. Reporting Requirements Fulfilled by this Report

Reporting Requirements		FY 03/04
Title and location in permit, 1999	**Title and location in SWMP, May 2003**	**Section of this Report**
Monitoring Strategy Report Update (Section K.2)	N.A.	Sections 2, 3 and 4
N.A.	Storm Water Monitoring Plan: 3 Year Action Plan (Table 7-1)	Sections 2, 3 and 4
Monitoring and Reporting Program (Section K.2.a)	Storm Water Monitoring Plan: Characterization Monitoring Plan (Table 7-1)	Section 4 and Appendix A
N.A.	Storm Water Treatment Technology Research Status Report (Table 7-1)	Section 2
N.A.	Erosion Control Research Status Report (Table 7-1)	Section 3

The objectives of the Storm Water Monitoring and BMP Development Status Report is to summarize the progress of the monitoring and BMP development studies conducted during the past year and outline work proposed over the next three years. This report will be included with the submission of the Annual Report to the State Water Resources Control Board (SWRCB). Table 1-2 provides summaries of current storm water characterization studies for FY 2004-05.

This report provides brief descriptions of each storm water characterization study, treatment technology study, erosion control study and a summary of the principal findings and conclusions to date.

3-Year Action Plans of expected deliverables and schedules are included for new or ongoing studies. All Department storm water studies are performed according to specific sampling analysis plans. The sampling and analysis plans are prepared based on the guidelines provided in the Department's Comprehensive Guidance Manual (CTSW-RT-03-105-51.42). The Department has developed software and manuals (CTSW-OT-03-002) that are consistently being used to collect representative samples, scientifically validate monitoring data, and report the data in a consistent manner. The primary application of these manuals for storm water characterization studies are briefly described in Appendix A.

The Treatment BMP Technology Report (CTSW-06-167.02.02) is a companion report that catalogs fact sheets for all identified treatment technologies.

Table 1-2. Summary of 2004-05 Storm Water Monitoring Activities

Section Number	RWQCB Region	Department District	Monitoring Sites	New or Ongoing	Target Constituents
2	**Storm Water Treatment Technology Studies**				
	Central Valley	2	I-5 PM 25.07 Partial Sedimentation Austin Sand Filter	Ongoing	NS
	Central Valley	2	Mt. Shasta Maintenance Station Full Sedimentation Austin Sand Filter	Ongoing	NS
	Lahontan	3	Hwy 50 (Near Meyers) (2) Media Filters	Ongoing	NS, Iron, Turbidity, Oil/Grease
	Lahontan	3	Small Scale Pilot Studies (at Meyers Maintenance Station)	Ongoing	NS, Iron, Turbidity, Oil/Grease
	Los Angeles	7	SR 91/Cerritos, PM 17.06	Ongoing	Litter
	Los Angeles	7	I-405/Leadwell, PM 42.6	Ongoing	Litter
	Los Angeles	7	I-210/Orcas, PM 8.63	Ongoing	Litter
	Los Angeles	7	I-210/Filmore, PM 6.44	Ongoing	Litter
	Los Angeles	7	I-101, PM 17.82	Ongoing	Litter
	San Diego	11	SR 56 CDS	Ongoing	NS. Litter
	San Diego	11	SR 56 CDS	Ongoing	NS, Litter
	San Diego	12	SR 73 – Orange County Bypass Detention Basin	Ongoing	NS
	San Diego	12	SR 73 – Orange County Bypass Detention Basin	Ongoing	NS
	San Diego	12	SR 73 – Orange County Semi-Batch Detention Basin	Ongoing	NS
	San Diego	12	SR 73 – Orange County Semi-Batch Detention Basin	Ongoing	NS
	San Diego	12	SR 73 – Orange County Semi-Batch Detention Basin	Ongoing	NS
	San Diego	12	SR 73 – Orange County Semi-Batch Detention Basin	Ongoing	NS
	San Diego	12	SR 73 – Orange County Detention Basin Floating Skimmer Outlet	Ongoing	NS

Section Number	RWQCB Region	Department District	Monitoring Sites	New or Ongoing	Target Constituents
	San Diego	12	SR 73 – Orange County Detention Basin Floating Skimmer Outlet	Ongoing	NS
	San Diego	12	SR 73 – Orange County Detention Basin Floating Skimmer Outlet	Ongoing	NS
	San Diego	12	SR 73 – Orange County Detention Basin – GSRD Inlet	Ongoing	NS
	San Diego	12	SR 73 – Orange County Detention Basin – GSRD Inlet	Ongoing	NS
	San Diego	12	SR 73 – Orange County Detention Basin – GSRD Inlet	Ongoing	NS
	Santa Ana	12	SR 73 – Orange County Bypass Detention Basin	Ongoing	NS
	Santa Ana	12	SR 73 – Orange County Bypass Detention Basin	Ongoing	NS
	Santa Ana	12	SR 73 – Orange County Overflow Detention Basin	Ongoing	NS
	Santa Ana	12	SR 73 – Orange County Overflow Detention Basin	Ongoing	NS
	Santa Ana	12	SR 73 – Orange County Overflow Detention Basin	Ongoing	NS
	Santa Ana	12	SR 73 – Orange County Overflow Detention Basin	Ongoing	NS
	Santa Ana	12	SR-73 Orange County GSRD – Reverse Sloping Screen	Ongoing	NS, Litter
	Santa Ana	12	SR-73 Orange County Inclined Screen with Front-end Loader Access	Ongoing	NS, Litter
3	**Erosion Control Studies**				
	Seed Mix and Vegetation Establishment Summary				
	Central Coast	5	Cal Poly San Luis Obispo	Ongoing	TSS
	Piloting Soil Stabilization: Permanent				
	TBD	TBD	TBD	New	TBD
4	**Storm Water Characterization Studies**				
	Specialized Characterization Studies				
	San Francisco Bay	4	Southbound Hwy 680 in Solano County	Ongoing	CTR Constituents
	Santa Ana	8	Eastbound Hwy 91 in Riverside County	Ongoing	CTR Constituents
	Los Angeles	7	Drain Inlet Cleaning Efficacy Study Sites	Ongoing	Litter

NS: Normal Suite = Conventionals + Nutrients + Metals
Conventionals: DOC, TOC, Hardness, TDS, TSS, Conductivity, Temperature, pH Nutrients: Nitrate-N, TKN, Total Phosphorous, Dissolved Ortho-Phosphate
Metals: As, Cd, Cr, Cu, Pb, Ni, Zn
PM: Postmile
RWQCB: Regional Water Quality Control Board

1.1 DEVELOPING DATA FOR PROGRAM EFFECTIVENESS ASSESSMENTS

The results of these studies will help in assessing program effectiveness of BMP implementation. As assessments become more advanced, the Department will seek to quantify the benefit of BMP implementation. This requires understanding of BMP performance for pollutants of concern. This effort will follow the model currently being developed by the California Stormwater Quality Association (CASQA).

1.2 REPORT ORGANIZATION

The remaining document is organized into four sections:

Section 2 provides descriptions of activities and studies conducted as part of the Department's storm water treatment technology development program.

Section 3 provides descriptions of erosion control studies conducted by the Department during the past year.

Section 4 provides descriptions of activities and studies conducted as part of the Department's storm water characterization program, which includes specialized characterization studies.

Section 5 contains general references. Documents specific for each study are listed within the corresponding section describing that study. The Table of Contents provides the location within this report of the various studies.

This section provides a brief summary and status of reconnaissance studies and ongoing pilot studies conducted by the Department during the past fiscal year (July 1, 2004 to June 30, 2005).

2.1 PREVIOUS STUDIES

Results from reports completed during last fiscal year (2004/2005) are summarized in Section 2.

Results of treatment technology studies completed prior to July 1, 2004 are summarized in the following reports:

- Roadside Vegetated Treatment Sites (RVTS) Study, Final Report, November 2003, CTSW-RT-03-028.
- Caltrans BMP Retrofit Pilot Program, Final Report, January 2004, CTSW-RT-01-050.
- Caltrans Tahoe Highway Runoff Characterization and Sand Trap Effectiveness Studies, 2002-2003 Monitoring Report, June 2003, CTSW-RT-03.054.36.02.

2.2 LITERATURE SEARCHES AND RECONNAISSANCE STUDIES

The first step in the Department's BMP selection process is accomplished through literature searches. Findings for treatment technologies are annually summarized in the Treatment BMP Technology Report (CTSW-RT-06-167.02.02), which is a companion document to this report. The second step involves performing reconnaissance studies and pilot studies for promising technologies. Reconnaissance studies are performed when additional information is required to determine whether a pilot study is worthwhile. Reconnaissance studies are more thorough engineering evaluations than the Treatment Technology Report provides and they often including preliminary cost estimates.

No reconnaissance studies were completed in the last fiscal year.

2.3 OVERVIEW OF PILOT STUDY PROGRAMS

The Department's pilot studies described in this section are being conducted under the Tahoe Basin Pilot Program, the District 12 State Route (SR) 73 Pilot Program, the Gross Solids Removal Device (GSRD) Program, and other pilot study efforts. These programs are described below. The individual pilot studies that make up each pilot program are organized by BMP type and are discussed in Sections 2.4 through 2.13.

Tahoe Basin Pilot Program

The Tahoe Basin Program consists of both small-scale and full-scale pilot testing, as well as sand trap monitoring. A small-scale test facility has been constructed at the Department's Myers Maintenance Station in the Lake Tahoe Basin. The test facility is in its fifth season of operation. Six full-scale pilot media filters have been constructed, and are currently being monitored. Four chemically enhanced detention basins (CEDBs) are currently being designed for construction and monitoring in 2006. The performance monitoring program for sand traps is complete and a final report is available (CTSW-RT-03-054.36.02).

District 12 SR73 Pilot Program

In 2001, the Department began a pilot program along the San Joaquin Hills Transportation Corridor (SR73) in Orange County. As part of this program, operation, maintenance, and monitoring of three Compost Storm Filter Pilots was performed. A final report with the results has been prepared and is available (CTSW-RT-03-036).

Design, construction, and or monitoring are currently underway for approximately 24 BMPs along SR73. The program includes 18 modified detention basins, three gross solids removal devices (GSRDs), one bioretention basin, and two sand filters.

District 7 Gross Solids Removal Device (GSRD) Pilot Program

The District 7 GSRD Pilot Program was initiated by the Department to develop and evaluate the performance of non-proprietary devices that can capture gross solids and that can be constructed into existing highway drainage systems or implemented in future highway drainage systems. The term "gross solids" includes litter, vegetation, and other particles of relatively large size.

Other Pilot Study Efforts

Other pilot study efforts include the Roadside Vegetated Treatment Sites (RVTS), San Francisco-Oakland Bay Bridge pilots, District 2 Austin-Type Sand Filters and District 11 Continuous Deflection Separators.

2.4 ALTERNATIVE MEDIA FILTERS

Alternative media filters use filtration media other than sand. Alternative media have the potential to remove dissolved constituents such as metals, nutrients, and trace organics that are not removed particularly well by sand. Alternative media may be arranged in either bed or canister configurations.

2.4.1 Tahoe Basin Pilot Program — Small-Scale Pilot Studies

Objectives

The Tahoe small-scale pilot treatment systems operate intermittently to treat discrete batches of storm water collected after various runoff events. Objectives of these pilot studies include:

- Testing the effectiveness of sedimentation and media filtration treatment systems in removing colloidal, dissolved and particulate storm water pollutants
- Developing design parameters for full-scale pilots

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
Meyers Maintenance Station, Lahontan, D-3	Varies	Fourth monitoring season (04/05) testing complete. Fifth monitoring season report anticipated in 2006.

Findings/Conclusions

First, second and third monitoring season reports are now complete. First season monitoring showed that the filtration systems tested, with the possible exception of activated alumina filtration, were ineffective when used without prior chemical addition and sedimentation. Second season monitoring and testing showed that filtration through activated alumina and expanded shale, following 24-hour sedimentation without chemical addition, almost always met the required surface water discharge limits. However, both media, expanded shale in particular, increased effluent pH and dissolved aluminum concentrations. Sedimentation without chemicals followed by fine sand filtration was found to be ineffective as a treatment system for the Tahoe Basin. Third monitoring season breakthrough testing to determine expected life of activated alumina, expanded shale, and other media showed that activated alumina had the longest treatment life as well as the best treatment performance. Fourth season testing included performance and breakthrough testing of new adsorptive media (iron-modified activated alumina, granular ferric hydroxide and a proprietary iron oxide) as well as further testing of activated alumina of various grain sizes. Fourth season testing indicated that iron-modified activated alumina had treatment performance comparable to activated alumina but reduced effluent pH and was more prone to hydraulic failure. Fifth monitoring season testing includes testing of activated alumina/iron-modified activated alumina dual media filters for preventing increases in effluent pH and aluminum. It also includes testing/development of small footprint filters.

Available Documents

Department Document No.	Document Title
CTSW-RT-01-054-D	Lake Tahoe Storm Water Treatment Pilot Project Monitoring and Operations Plan. October 2001.
CTSW-RT-03-042	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase I Report.
CTSW-RT-03-053.33.41	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project Phase II Monitoring and Operations Plan. June 2003.
CTSW-RT-03-079.31.37	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase II Report.
CTSW-RT-04-069.04.04	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project Phase III Monitoring and Operations Plan. June 2004.
CTSW-RT-05-069.04.07	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase III Final Report.
CTSW-RT-05-069.04.08	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project Phase IV Monitoring and Operations Plan. January 2005.
CTSW-RT-05-129.05.01	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase IV Report.

Department Document No.	Document Title
CTSW-RT-05-157.04.01	Caltrans Lake Tahoe Storm Water Small Scale Pilot Treatment Project, Phase V Monitoring and Operations Plan

3-Year Action Plan

Overview of Approach

The study will continue with media that has shown the most promise based on past results and new media identified through literature reviews. 4-inch columns will be used to test removal efficiencies and treatment life for different media.

Products or Deliverables

- Reconnaissance study or other literature review reports
- Site-specific Monitoring and Operations Plans
- Final reports summarizing and analyzing data collected

Schedule

Monitoring will likely continue for the next three years. Annual or interim reports will be prepared to document specific reports.

2.4.2 Tahoe Basin Pilot Program — Large-Scale Pilot Studies

Six full-scale pilot BMPs have been constructed using activated alumina, iron-modified activated alumina and limestone as the filter media. Activated alumina and iron-modified activated alumina showed some promise for removing turbidity and nutrients from storm water when tested in the small-scale pilot facility. Limestone gave slightly better nutrient removal than fine sand in small-scale tests. All six filters are modeled after partial sedimentation type Austin-style sand filters, but have twelve or twenty-four inches of media overlain by six inches of sand rather than the typical 18-inch layer of sand. The table below lists the full-scale media filters currently being monitored in the Tahoe:

Media Filter	Location	Construction Date
Activated Alumina (12-inch depth)	Hwy 50	2003
Activated Alumina (12-inch depth, reduced area)	Hwy 50	2003
Limestone (24-inch depth)	SR267	2005
Activated Alumina (24-inch depth)	SR267	2005
Iron-modified Activated Alumina (24-inch depth)	SR267	2005
Iron-modified Activated Alumina (24-inch depth, reduced area)	SR267	2005

Objectives

These pilots were designed to determine:

- The effectiveness of various filter media in removing turbidity and nutrients
- The hydraulic performance of the media filter BMPs in the alpine climate
- The maintenance requirements
- Construction and maintenance cost

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
HWY 50, Lahontan, D-3	2	Construction complete, monitoring is ongoing. Final report anticipated in 2006.
SR267, Lahontan, D-3	4	Construction complete, monitoring is ongoing. Final report anticipated in 2008.

Findings/Conclusions

First season monitoring of the Hwy 50 activated alumina filters showed that activated alumina filters are promising for turbidity and nutrient removal. There was no evidence that media effectiveness had decreased at the end of the first season of monitoring.

Available Documents

Department Document No.	Document Title
CTSW-RT-03-061.31.37	Caltrans Tahoe Basin Highway 50 Full-Scale BMP Pilot Study Monitoring Season 2003-2004. Sampling and Analysis Plan. June 2003.
CTSW-RT-05.129.02.1	Highway 50 Activated Alumina Media Filter Pilot Study. 2003-2004 Interim Report.
CTSW-RL-05-129.02.1	Caltrans Tahoe Basin Full-Scale Activated Alumina BMP Pilot Study, Monitoring Season 2004-2005. Monitoring and Operations Plan. March 2004.
CTSW-RT-05-157.02.1	Highway 50 Activated Alumina Media Filter Pilot Study, Monitoring Season 2005-2006. Monitoring and Operations Plan. October 2004.
CTSW-RT-05-157.03.1	Highway 267 Media Filter Pilot Study, Monitoring Season 2005-2006. Monitoring and Operations Plan. November 2004.

3-Year Action Plan

Products and Deliverables

Interim data reports should be produced at the end of each sampling year, while a final report will be produced when the study is complete.

Schedule

Monitoring will continue during the 05/06 wet season for the Hwy 50 activated alumina filters, and during the 05/06, 06/07 and 07/08 wet seasons for the SR267 media filters.

2.5 BIORETENTION

Bioretention refers to a system in which storm water is captured and infiltrated in a shallow, typically offline, vegetated basin. Storm water pollutants are removed through physical and biological processes, including adsorption, filtration, plant uptake, microbial activity, decomposition, sedimentation and volatilization. Bioretention facilities typically include a pretreatment biofilter (vegetated swale or strip) to reduce velocities and filter out particulates, a sand trench to augment the infiltration capacity of the planted bed and to evenly distribute incoming runoff and a ponding area to collect and store runoff prior to infiltration. Sometimes an underdrain system is provided to capture and transport the infiltrated runoff.

2.5.1 San Francisco–Oakland Bay Bridge — Bioretention

As part of the San Francisco-Oakland Bay Bridge (SFOBB) East Span Seismic Safety Project (ESSSP), the Department is proposing to treat storm water on the eastern portion of the ESSSP (i.e., Oakland Approach) and the SFOBB Toll Plaza using bioretention filters and other approved BMPs.

Objectives

This pilot is designed to determine:

- Effectiveness of the bioretention filter in removing constituents of concern
- Construction costs
- Operations and maintenance costs

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
I-80, San Francisco, D-4	2	In design. Final report anticipated in 2012.

Findings/Conclusions

None

Available Documents

Department Document No.	Document Title
not available	Engineering Design of Storm Water Treatment BMPs for Oakland Bay Bridge Approach. Basis of Design Report.

3-Year Action Plan

Overview of Approach

- Prepare sampling and analysis plans (SAP).
- Perform in and out water quality monitoring.
- Prepare a Final Report documenting performance and cost.

Products or Deliverables

- As-builts
- SAP
- Monitoring Reports
- Final Report

Schedule

Construction is expected to begin in 2006/07 and continue through 2007/08. Plant establishment will finish in 2008/09. Monitoring will begin in 2009/10 and continue through the 2010/11 and 2011/2012 seasons.

2.5.2 District 12 SR73 Pilot Program — Bioretention

Objectives

The Department will be replacing an existing CSF and basin along the San Joaquin Hills Transportation Corridor (SR73) with a bioretention filter. Siting, design, and construction of the bioretention filter is complete.

These pilots are designed to determine:

- Effectiveness of the bioretention filter in removing constituents of concern
- Construction costs
- Operation and maintenance costs

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
SR 73, Santa Ana, D-12	1	Construction complete. Plant establishment period ends Summer 2006. Water quality monitoring to begin Fall 2006. Final report anticipated in 2009.

Findings/Conclusions

None

Available Documents

Department Document No.	Document Title
CTSW-RT-03-006.51.39	Basis of Design report, SR-73 Storm Water BMP Replacement Project at CSF System 1149L Bioretention Area, November 2003

3-Year Action Plan

Overview of Approach

- Prepare sampling and analysis plans (SAP).
- Perform in and out water quality monitoring.
- Prepare a Final Report documenting performance and cost.

Products or Deliverables

- As-builts
- SAP
- Monitoring Reports
- Final Report

Schedule

Monitoring should begin in 2005/06 and continue through 2007/08 – 2008/09.

2.6 CHEMICAL TREATMENT

Chemical addition is intended to improve phosphorus and particulate removal (by precipitation and coagulation followed by settling) or as a filter aid to improve filtration performance.

2.6.1 Tahoe Basin Small-Scale Test Facility — Small-Scale Pilot Studies

Objectives

The objectives of testing chemical treatment systems are to determine:

- Effectiveness of chemical addition for improving pollutant removal
- Appropriate chemical additive doses for storm water treatment
- Sensitivity of performance to dose to determine technical feasibility of dosing variable flows
- Negative impacts to water quality due to added chemicals

Current Status

A number of chemicals have been tested in jar test and/or settling rate experiments, including PASS-C® and PAX-XL9® (both polyaluminum chlorides), PAM, and chitosan (a naturally occurring biopolymer). The "mechanized" systems tested included proprietary high-rate Actiflo® clarification and non-proprietary conventional clarification with PASS-C®.

Location (Route, RWQCB, District)	No. of Pilots	Status
Meyers Maintenance Station, Lahontan, D-3	Varies	Third monitoring season (04/05) testing complete. Third monitoring season report expected in 2006.

Findings/Conclusions

First, second and third monitoring season reports are now complete. First season monitoring (01/02) showed the effectiveness of PASS-C®-assisted sedimentation. Second season (02/03) testing with PASS-C® and liquid chitosan suggested that chemical treatment followed by sedimentation alone may be sufficient to meet the surface water discharge limits in some situations. PASS-C addition, however, lowers effluent pH, sometimes to below 6.5. Both the proprietary and non-proprietary mechanized systems met all the surface discharge standards in all the second monitoring season experimental runs. Third season (03/04) experiments with PASS-C®, PAX-XL9® and chitosan showed that PASS-C® and PAX-XL9® gave similar turbidity removal and for both a dose of 100 mg/L appeared to be an effective dose for most storms. Chitosan was not as effective as the two polyaluminum chlorides for the storms tested during the third season. Settling experiments with PASS-C® and PAX-XL9® indicated that a turbidity of 20 NTU could be achieved in 2- 6 hours when dosed optimally. Fourth season (04/05) testing included further jar testing and settling rate experiments (PASS-C®, PAX-XL9®, two anionic polyacrylamides, JenChem 1720®, Sumachlor 50®) as well as toxicity testing of chemical dosed storm water.

Available Documents

Department Document No.	Document Title
CTSW-RT-01-026	Chemical Treatment to Improve Settling Reconnaissance Study.
CTSW-RT-01-054-D	Lake Tahoe Storm Water Treatment Pilot Project Monitoring and Operations Plan. October 2001.
CTSW-RT-03-042	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase I Report.
CTSW-RT-03-053.33.41	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project Phase II Monitoring and Operations Plan. June 2003.
CTSW-RT-03-079.31.37	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase II Report.
CTSW-RT-04-069.04.04	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project Phase III Monitoring and Operations Plan. June 2004.
CTSW-RT-03-063.33.41	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Jar Test Results and SummaryReport
CTSW-RT-01-026	Chemical Treatment to Improve Settling Reconnaisance Study.

3-Year Action Plan

Overview of Approach

- Literature searches and reconnaissance studies for selection of promising chemicals and chemical applications method
- Selection of pilot treatments systems for testing
- Development of a site-specific Monitoring and Operations Plan
- Design, construction and modification of new and existing pilot systems
- Operation, maintenance and monitoring

Products and Deliverables

- Reconnaissance study or other literature review reports
- Site-specific Monitoring and Operations Plans
- Post-storm technical memoranda
- Final reports summarizing and analyzing data collected

Schedule

Monitoring will likely continue for the next three years. Annual or interim reports will be prepared to document specific reports.

2.7 DETENTION BASINS

Detention basins (DBs) temporarily store water to allow solids and associated pollutants to settle out. Storage is achieved by limiting the rate of flow out of the basin, typically through the use of small (approximately 1-inch diameter) orifices on an outflow riser. Runoff volumes greater than the predetermined design storm water quality volume (WQV) are either routed around the basin or through the basin via an overflow weir or standpipe.

2.7.1 District 12 SR73 Pilot Program — Bypass Detention Basins

Existing SR73 equalization basins have been modified to evaluate the effect that decreasing the basin volume has on detention times and pollutant removal abilities of bypass DBs. Bypass DBs use a splitter box upstream of the basin to divert water around the basin once a predetermined basin depth is reached. In this study, basins were sized at approximately 100, 75, 50 and 25 percent of the design storm WQV. Coincident to this study, three other studies will allow comparison of bypass-type operation with overflow-type operation, "semi-batch" operation, and surface drained (skimmer). (See sections 2.7.2-2.7.4.)

Objectives

These pilots are designed to determine:

- Relationships between basin volume, detention time and removal efficiency (or irreducible concentration) in bypass DBs
- Construction costs in the Department's retrofit environment
- Operation and maintenance costs
- How the performance of bypass DBs compares to that of overflow, surface drained, and semi-batch DBs

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
SR73, San Diego and Santa Ana, D-12	4	Construction complete. Water quality monitoring continued. Final report anticipated in 2008.

Findings/Conclusions

None

Available Documents

Department Document No.	Document Title
CTSW-RT-01-029	Detention Basin Optimization-Reconnaisance Study Final Report

3-Year Action Plan

This three-year action plan covers all of the bypass, overflow, surface drained, and semi-batch basins.

Water quality and operational monitoring will be conducted for at least two wet seasons (04/05 and 05/06). A final report will be produced after enough data has been gathered to make statistically significant determinations regarding performance.

Products and Deliverables

A Final Report will be produced, likely in 2008.

Schedule

2004/05	Operational monitoring only
2004 - 2007	Operational and water quality monitoring.
2008	Production of final report.

2.7.2 District 12 SR73 Pilot Program — Overflow Detention Basins

Existing SR73 equalization basins have been modified to evaluate the effect of decreasing the basin volume on detention times and pollutant removal abilities of overflow DBs. In overflow DBs, water in excess of the design WQV will flow into the basin and out over a flood control weir or standpipe. Basins will be sized at approximately 100, 75, 50 and 25 percent of the design storm volume.

Objectives

These pilots are designed to determine:

- Relationships between basin volume, detention time and removal efficiency (or irreducible concentration) in overflow DBs
- Construction costs in the Department's retrofit environment
- Operation and maintenance costs
- How the performance of overflow DBs compares to that of bypass, surface drained, and semi-batch DBs

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
SR73, Santa Ana, D-12	4	Water quality monitoring continued. Final report anticipated in 2008.

Findings/Conclusions

None

Available Documents

Department Document No.	Document Title
CTSW-RT-01-029	Detention Basin Optimization-Reconnaissance Study Final Report

3-Year Action Plan

See the three-year action plan for bypass detention basins.

2.7.3 District 12 SR73 Pilot Program — Semi-Batch Detention Basins

Existing SR73 equalization basins are being modified to evaluate the effects of semi-batch operation and varying pond volume on detention time and pollutant removal efficiency. Semi-batch operation (also called hold-and-release) is achieved by installing a valve on the outlet of an overflow DB. During storms, when the basin begins to fill, the valve closes. This creates a quiescent pool that is expected to improve settling by retarding water movement. After some chosen time (e.g., 24 hours) has elapsed, the valve will open and the basin will drain like a normal DB. Inflow in excess of the pond design volume will overflow a weir. Like the bypass and overflow basins, the semi-batch basins will be sized at approximately 100, 75, 50 and 25 percent of the design storm WQV.

Objectives

These pilots are designed to determine:

- Technical feasibility of various hold-and-release valves
- Relationships between basin volume, detention time and removal efficiency (or irreducible concentration) in semi-batch DBs
- Construction costs in the Department's retrofit environment
- Operation and maintenance costs
- How the performance of semi-batch DBs compares to that of bypass, overflow, and surface drained DBs

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
SR73, San Diego, D-12	4	Construction is complete. Water quality monitoring to started in 2005/2006 wet season. Final report anticipated in 2008.

Findings/Conclusions

Available Documents

Department Document No.	Document Title
CTSW-TM-01-005	Inlet/Outlet Alternatives For Extended Detention Basins Technical Memorandum.

3-Year Action Plan

See the three-year action plan for bypass detention basins (section 2.7.1).

2.7.4 District 12 SR73 Pilot Program — Surface Drained Detention Basins (Floating Skimmer Outlet)

Objectives

Existing SR73 equalization basins are being modified with floating skimmer outlets to determine if decanting water from the top of a detention basin rather than the bottom improves pollutant removal. The outflow skimmer is composed of a float and an attached pipe with orifices. Inflow in excess of the WQV will overflow a weir.

These pilots are designed to determine:

- Technical feasibility of floating skimmers
- Relationships between basin volume, detention time and removal efficiency (or irreducible concentration) while using a floating skimmer
- Construction costs in the Department's retrofit environment
- Operation and maintenance costs
- How the performance of surface drained DBs compares to that of bypass, overflow, and semi-batch DBs.

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
SR73, San Diego, D-12	4	Construction on three of the basins are complete. The fourth basin is under construction due to conflicts with a ramp realignment project that is now complete. Final report anticipated in 2008.

Findings/Conclusions

None

Available Documents

Department Document No.	Document Title
CTSW-TM-01-005	Inlet/Outlet Alternatives For Extended Detention Basins Technical Memorandum.

3-Year Action Plan

See the three-year action plan for bypass detention basins (section 2.7.1).

2.7.5 District 12 SR73 Pilot Program — Alternative Inlet

Objectives

The objective is to test the use of approved linear radial GSRD in conjunction with detention basins. Existing SR73 equalization basins will be retrofit with the Department's linear radial GSRD to examine the improvement to water quality and the effect on maintenance costs associated with dissipating flow energy and capturing litter as it enters a detention basin. Three linear radial GSRDs are being tested.

CSFs 1076R & 1081L:

- LR1 Linear Radial Configuration 1

CSF 1085L:

- VS1 V-screen Configuration 1

CSF 1180R:

- IS3 Inclined Screen Configuration 3

These pilots are designed to determine:

- Technical feasibility of using a linear radial GSRD to dissipate flow energy
- Technical feasibility of using a linear radial GSRD to trap litter in a detention basin
- Construction costs in the Department's retrofit environment
- Operation and maintenance costs

Current Status

Location (Route, RWQCB, District)	**No. of Pilots**	**Status**
SR73, San Diego, D-12 1076 R 1081 L	 (1) (2)	Construction complete. Operational monitoring continued in 05/06. Final report anticipated in 2008.
SR-73, Santa Ana, D-12	1 V-screen Configuration 1	GSRD on Basin 1085L: Construction complete. Final report anticipated in 2006.
SR-73, Santa Ana, D-12	1 Inclined Screen Configuration 3	GSRD on basin 1180R: Construction complete. Final report anticipated in 2007.

Findings/Conclusions

None

Available Documents

Department Document No.	Document Title
CTSW-TM-01-005	Inlet/Outlet Alternatives For Extended Detention Basins Technical Memorandum.

3-Year Action Plan

See the three-year action plan for District 12 SR73 Pilot Program — GSRDs (section 2.7.1).

2.8 DRAIN INLET INSERTS

Drain inlet inserts (DIIs) tend to be utilized as a post construction method for removing such constituents as metals, sediment, and oil and grease. Drain inlet inserts can typically be installed with one to two people. DIIs are placed into stormwater catchbasins. DII can be placed in several categories such as: baffle boxes, boxes/baskets, fabric, media filters, and screens.

Objectives

The purpose is to developed a non-proprietary DII design and modify an existing DII (Drain Pac® and Ultra-Urban®) in order to improve removal efficiencies from previous studies. Also to evaluate the removal efficiencies for zinc, copper, sediment, and oil and grease. Medias tested are compost and peet as a filter media for the before mentioned constituents. Also being considered are zeolite.

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
Sacramento State (Central Valley, District 3)	4	Testing to begin in FY 05/06

Findings/Conclusions

Previous testing by OWP for the California Integrated Waste Management Board can be viewed at www.owp.csus.edu/research.

No results are available from current testing.

Available Documents

None available.

2.9 GROSS SOLIDS REMOVAL DEVICES

GSRDs include physical/mechanical methods of removing litter and solids five millimeters (mm) (0.25-inch nominal) and larger from the storm water runoff using various screening technologies. The objective of the GSRD pilots is to test end-of-pipe treatment devices that can be incorporated into existing or future highway drainage systems to capture litter and other coarse solids (collectively known as "gross solids").

2.9.1 District 7 GSRD Pilot Program

Objectives

The District 7 GSRDs were developed to help meet the requirements of the Los Angeles RWQCB's adopted total maximum daily load (TMDL) for litter for the Los Angeles River Watershed and Ballona Creek Watershed. Nine different types of GSRDs are being tested in the Los Angeles River, Ballona Creek, and San Gabriel watersheds in District 7. The GSRD names are in the following lists and descriptions are in the following text.

Linear Radial Devices (LRD):

- LR1 Configuration 1 – louvered well casing at 2-percent slope (approved)
- LR2 Configuration 2 – wire mesh screens with nylon mesh bags (study complete – concept abandoned)
- LR3 Configuration 3 – louvered well casing placed at 35-percent slope (steep slope study See I-101 PM 17.82)

Inclined Screen Devices (ISD):

- IS1 Configuration 1 – parabolic wedge wire screen for vacuum truck cleaning (approved)
- IS2 Configuration 2 – parabolic bars (study complete- concept abandoned)
- IS3 Configuration 3 – parabolic wedge wire screen for front-end loader cleaning (study complete- design changes being considered)
- IS4 Configuration 4 – wedge wire screen, direct flow (study complete- considering changes)
- IS5 Configuration 5 – wedge wire screen (study ongoing see I-210 Orcas, I-210 Filmore, and 91 at Cerritos studies)

Baffle Box (BB) (study complete – concept abandoned)

- BB1 Configuration 1

V-screens (VS) (study complete – concept abandoned)

- VS1 Configuration 1 – forward sloping screen (FSS)
- VS2 Configuration 2 – reverse sloping screen (RSS)

Linear Radial Device (LRD) – Configuration 1 uses modular well casings with 5-mm (0.25-inch nominal) louvers to remove litter. Flow enters the casing and passes radially through the louvers, trapping litter and solids inside. The clean water flows into a vault holding the GSRD and is directed to an outlet pipe. Access doors are provided on the well casings for ease of maintenance and cleaning using a vactor truck. Configuration 2 uses modular well casing with 5 mm x 5 mm rigid mesh screen housing. Inside the screen are nylon mesh bags with 5 mm openings that capture gross solids. Configuration 3 is similar to Configuration 1 except that the modular well casings are placed on a 35-percent slope.

Inclined Screen Device (ISD) – In Configuration 1, flow overtops a weir and falls through an inclined parabolic wedge wire screen with 3 mm spacing. Litter stopped by the screen falls or is pushed down the face of the screen into a litter storage area. The litter storage area is sloped and is provided with a drain to prevent standing water. Configuration 2 uses a 5 mm spaces. Configuration 3 is the same as Configuration 1, except it has access for cleaning by a front-end loader. Configuration 4 contains a straight screen rather than a curved one; and runoff discharges onto the screen at a single point instead of being uniformly distributed across the width of the screen by an influent trough. Configuration 5 uses wedge wire screens oriented in a U-shape with a concrete head wall. Runoff enters the device, hits the head wall, and flows along a platform where the runoff flows onto the wedge wire screens.

Baffle Box–This device applies a two-chamber concept. The first chamber utilizes an underflow weir and 50-mm screen to trap floatable litter. The second chamber uses a 5-mm screen to capture materials that get past the underflow weir and 50-mm screen. Once the flow enters this device, reduced velocities allow solids to settle. Peak flow velocities are maintained at levels that will not re-suspend solids. Litter entering the device generally floats; however, some will eventually settle. Storage is provided for both floatable and settleable litter.

V-screens – Configuration 1 is an open-ended concrete box with a wedge wire, v-shaped screen. The v-shaped screen is placed directly in front of a discharge pipe with the vertex of the "v" along the centerline of the inlet pipe. The screen diverts litter toward the sides of the concrete box. The screen is also at a positive inclination; that is, the top of the screen is slightly farther away from the incoming flow than the bottom of the screen. The difference between Configuration 1 and Configuration 2 is the positive or negative inclination of the screen. Configuration 2 contains a screen at a negative inclination, that is, the bottom of the screen is slightly farther away from the incoming flow than the top of the screen.

These pilots are designed to determine:

- Effectiveness of GSRDs in removing gross solids
- Construction costs
- Operation and maintenance costs

Current Status

Location (Route, RWQCB, District, PM)	No. of Pilots	Status
I-210 Orcas, PM 8.63	1 Inclined Screen – Conf. 5 (ISS)	Under construction
I-210 Filmore, PM 6.44	1 Inclined Screen – Conf. 5 (ISS)	Under construction

Location (Route, RWQCB, District, PM)	No. of Pilots	Status
91 at Cerritos, PM 17.06	1 Inclined Screen – Conf. 5 (ISS)	Under construction
I 405 / Leadwall, Los Angeles, District 7, PM 42.6	1 Forward Sloping V Screen (VS1)	Concept abandoned, under redesign
I 101, Los Angeles, District 7, PM 17.82	1 Steep-slope linear radial (LR3)	Operational monitoring

Findings/Conclusions

The Linear Radial Configuration 1 and Inclined Screen Configurations 1 and 4 were determined to be effective at removing gross solids from storm water runoff. The Linear Radial Configurations 2 and 3, Inclined Screen Configuration 2, Baffle Box and V-screen Configurations 1 and 2 were determined to be either too maintenance intensive or ineffective. As a result, these devices have been removed from further consideration. The Inclined Screen Configuration 3 proved to be a valid design concept. However, a re-design has been recommended to eliminate the intensive cleaning requirements that were documented throughout the study period. The remaining GSRDs are still under evaluation.

Available Documents

Department Document No.	Document Title
CTSW-RT-03-072.31.22	Phase 1 Gross Solids Removal Devices Pilot Study: 2000-2002. Final Report October 2003.
CTSW-RT-01-005	Preliminary Design Report: Litter Solids Removal Device. January 2001
CTSW-RT-01-047	Gross Solids Removal Device Pilot Study 2000-2001 Interim Report.
CTSW-RT-01-004	Sampling and Analysis Plan: Litter Solids Removal Device Pilot Study. January 2001.
CTSW-RT-03-099.31.24	Phase III Gross Solids Removal Devices Pilot Study: 2002-2003 Interim Report. November 2003.
CTSW-RT-03-098.31.17	Phase III Gross Solids Removal Devices Basis of Design Report. November 2003.
CTSW-RT-03-077.31.24D	Phase IV Gross Solids Removal Devices, Operations, Maintenance, and Monitoring Plan. Monitoring Season 2003-2004. September 2003.
CTSW-RT-02-071	Phase II & III Gross Solids Removal Devices , Operations and Maintenance Plan Monitoring Season 2002-2003. November 2002
CTSW-RT-03-097.31.22	Phase II Gross Solids Removal Devices Pilot Study: 2001-2003. Final Report November 2003.
CTSW-RT-01-069	Basis of Design Report: Gross Solids Removal Device Pilot Study, Phase II. November 2001.
CTSW-RT-05-130-03.2	Phase IV Gross Solids Removal Devices Pilot Study: 2002-2005
CTSW-RT-05-130-03.1	Phase III Gross Solids Removal Devices Pilot Study: 2002-2005

Department Document No.	Document Title
CTSW-RT-04-0130.03.1	Phase III and IV Gross Solids Removal Devices Operations, Maintenance and Monitoring Plan, Monitoring Season 2005-2005

3-Year Action Plan

Overview of Approach
Operational monitoring.

Products and Deliverables
Annual O&M reports

Schedule
Monitoring to begin in the 2006/2007 wet season and continue for 3 seasons.

2.9.2 District 12 SR73 Pilot Program — GSRDs

Objectives

In response to Cease and Desist Order No. 2001-198 issued by the San Diego RWQCB, the Department will be replacing three existing CSFs along the San Joaquin Hills Transportation Corridor (SR73) with GSRDs. The CSF sites with the GSRD names are in the following lists and descriptions are provided in Section 2.10.2:

CSF 630L:

- IS5 Inclined Screen Configuration 5

This pilot is designed to determine:

- Effectiveness of GSRDs in removing gross solids
- Construction costs
- Operations and maintenance costs

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
SR-73, San Diego, D-12	Inclined Screen Configuration 5	GSRD on basin 630L: Awaiting construction. Estimated date of completion of construction Spring 2005. Final report anticipated in 2006.

Findings/Conclusions

None

Available Documents

Department Document No.	Document Title
CTSW-RT-03-121.31.10	SR-73 Storm Water BMP Replacement Project at CSF System 1085L and 630L Gross Solids Removal Device. Basis of Design Report December 2003.
CTSW-RT-03-030	SR-73 1085L GSRD with Sediment Trap, Operations, Maintenance, and Monitoring Plan Monitoring Season 2002-2003. January 2003.
CTSW-RT-03-120.31.25	SR-73 Storm Water BMP Replacement Project at CSF System 1085L GSRD Interim Report. December 2003.
CTSW-RT-05-131-01.1	District 12 State Route 73 Pilot Program

3-Year Action Plan

Overview of Approach
Continue monitoring devices for litter loading rates, maintenance requirements, and operational problems.

Products and Deliverables
Final report on cost, performance, and maintenance requirements.

Schedule
Monitoring should continue through the 05-06 wet season. The final report will be prepared in FY 2006.

2.9.3 District 11 — Continuous Deflection Separators

The Department's District 11 has installed two CDS® units on SR-56. Sorbent material (sand) was inserted in these units to reduce discharges of oil and grease from the highway surface. These CDS® units also have weep holes at the bottom to facilitate drainage of standing water.

Objectives

These pilots are designed to determine:

- Effectiveness of CDS in removing pollutants of concern
- Effectiveness of weep holes in draining standing water

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
SR-56, Carmel Creek Road and Carmel County Road, San Diego, D-11	2	Third year monitoring (04/05) is complete. Water quality monitoring to continue in following three wet seasons. Final report anticipated in 2009.

Findings/Conclusions

Weep holes did not work to prevent standing water.

Available Documents

Department Document No.	Document Title
CTSW-RT-03-121.650.05	SR-56 CDS® and receiving water monitoring

3-Year Action Plan

Overview of Approach
Continue monitoring per agreement with the San Diego RWQCB.

Products and Deliverables
Final Report on performance expected in 2009.

Schedule
Monitoring will continue through the 2006/2007 wet season.

2.9.4 Laboratory Testing of Gross Solids Removal Devices

Objectives

These pilots are designed to determine the hydraulic performance of the proposed devices under different flow rates and debris-loading conditions. The results of these tests will help with the creation of standard specifications for Caltrans engineers.

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
UC Davis Hydraulic Lab	3	Tests are ongoing.

Findings/Conclusions

None

Available Documents

None

3-Year Action Plan

Overview of Approach
Conduct flow tests with different flow rates, slope and solids loadings through 2006.

Products and Deliverables
Final Report expected in 2006.

Schedule
Laboratory tests will continue through 2006. A final report is expected in 2006.

2.10 INFILTRATION

Infiltration technologies temporarily store water and cause it to infiltrate into the soil. Runoff volumes greater than the predetermined design WQV are typically routed around infiltration devices.

2.10.1 Infiltration Basin Model – Effects on Soil and Groundwater

Objectives

The purpose of this study is to model the long-term impact of infiltrating storm water on soils and groundwater. Specifically, the study will ascertain which constituents may leach to groundwater and exceed standards and which constituents may accumulate in the soil and exceed standards. The questions this study hopes to answer are:

- How quickly will the constituents build-up in the soil?
- How often will maintenance be required?
- Will the soil become a hazardous material?
- How deep will the constituents travel?
- Will constituents pollute the ground water?

The study is modifying existing models to predict the accumulation rates, depths, and concentrations of constituents over time. Effects of incidental infiltration through vegetated surfaces, such as biofilters, will also be considered.

Current Status

A final report has been post-poned to Winter 2007 to incorporate revisions to the model.

Findings/Conclusions

None

Available Documents

None

3-Year Action Plan

Overview of Approach

Finish modeling of existing pollutants, including herbicides. Validating the model with experimental data is proposed after completion of the Final Report.

Products and Deliverables

- Final report.

Schedule

Final report including herbicide analysis and incidental infiltration is delayed till Summer 2006 to incorporate additional analysis.

2.11 SAND FILTERS

Sand filters treat storm water by sedimentation and filtration through sand.

2.11.1 District 2 — Austin Sand Filters

Two different designs exist for Austin type sand filters: so called "separate" and "combined" sedimentation, also known as "full" and "partial," respectively. A separate sedimentation filter has separate sedimentation and filtration basins. The entire WQV is detained in the sedimentation basin and slowly discharged to the filter. A combined sedimentation filter has a combined sedimentation and filtration basin. In this design, the invert of the basin is the filter bed. Both of these designs are being piloted in District 2. The five Austin-type sand filters constructed and monitored in Southern California as part of the BMP Retrofit Pilot Program were all full sedimentation devices. In contrast to the Southern California pilot filters, the District 2 filters have earthen (rather than concrete) sidewalls.

Objectives

These pilots are designed to determine:

- Constituent removal effectiveness for each type of Austin sand filter
- Costs of constructing the full sedimentation Austin sand filter using earthen walls and bottom
- Construction costs and additional maintenance requirements of the partial sedimentation design
- Any additional maintenance requirements and costs for these sand filters in areas with relatively large annual rainfall and freezing temperatures
- Comparison of cost and performance to the Caltrans BMP Retrofit Pilot Program Austin sand filters

Current Status

Water quality monitoring continuing through the 2005/2006 wet season.

Location (Route, RWQCB, District)	No. of Pilots	Status
I-5 PM 25.07, Central Valley, D-2	1	Two and a half seasons of monitoring complete. Monitoring to continue through the 05/06 wet season. Final report anticipated in 2006.

Location (Route, RWQCB, District)	No. of Pilots	Status
Mt. Shasta Maintenance Station, Central Valley, D-2	1	Two seasons of monitoring complete. Monitoring to continue through 05/06 wet season. Final report anticipated in 2006.

Findings/Conclusions

Performance is similar to the Caltrans BMP Retrofit Pilot Program sand filters.

Available Documents

Department Document No.	Document Title
CTSW-RT-03-038	2002/2003 Monitoring Report, Caltrans District 2 Sand Filter Study.
CTSW-RT-01-086	Basis of Design Report: Austin-type Sand Filter Cold Climate Application in Siskiyou County at the Mount Shasta Maintenance Station. May 2001.
CTSW-RT-01-085	Basis of Design Report: Austin-type Sand Filter Cold Climate Application in Shasta County Adjacent to Interstate 5 near the Mountain Gate Overcrossing. June 2001.
CTSW-RT-01-034	Research Plan for Alternative Configurations and Pretreatment Options for Sand Filters. July.
CTSW-RT-04-128.01.01	Water Quality Monitoring Sampling and Analysis Plan
CTSW-TM-04-128.01.1	Caltrans District 2 Sand Filter Study, Cold Climate Application, End-of-Season Technical Memorandum No. 1
CTSW-RT-05-128.01.1	Caltrans District 2 Sand Filter Study 2004-2005 Storm Water Monitoring Report
CTSW-RT-05-128.01.2	Caltrans District 2 Sand Filter Study Water Quality Monitoring Sampling and Analysis Plan

3-Year Action Plan

Overview of Approach
Continue monitoring to achieve higher confidence in performance members.

Products and Deliverables
Final Report on cost, performance, and maintenance Requirements.

Schedule
Continue Monitoring through the 2005/2006 wet season.

2.11.2 Tahoe Basin Small-Scale Test Facility — Small-Scale Pilot Studies

Objectives

The Tahoe small-scale pilot treatment systems operate intermittently to treat discrete batches of storm water collected after various runoff events. The objectives of these pilot studies include:

- Testing the effectiveness of sedimentation and sand filtration treatment systems in removing colloidal, dissolved and particulate storm water pollutants
- Developing design parameters for full-scale pilots

Current Status

First season (01/02) monitoring included testing filter systems with one of three different sand media: coarse (~ 1 mm), fine (~ 0.5 mm) and concrete (~ 0.2 mm). Arrangements of coarse and fine sand tested included: direct filtration, direct filtration with filter aid, direct filtration with coagulant and filtration following coagulant and sedimentation. One system tested concrete sand in a simulation of a typical Austin sand filter. Second, third and fourth season monitoring objectives included further evaluation of fine sand as well as alternative media.

Location (Route, RWQCB, District)	No. of Pilots	Status
Meyers Maintenance Station, Lahontan, D-3	2 (Fine Sand)	Fourth monitoring season (04/05) testing complete. Fifth monitoring season report expected in 2006.

Findings/Conclusions

First, second and third monitoring season reports are now complete. First season monitoring showed that the sand filter systems tested were ineffective when used without prior chemical addition and sedimentation. Second and third season monitoring confirmed that sedimentation without chemicals followed by fine sand filtration was ineffective as a treatment system for meeting the numeric discharge limits in the Tahoe Basin. Fourth and fifth season monitoring of fine sand filters is for control purposes to compare the treatment effectiveness of adsorptive media.

Available Documents

Department Document No.	Document Title
CTSW-RT-01-054	Lake Tahoe Storm Water Treatment Pilot Project Monitoring and Operations Plan. October 2001.
CTSW-RT-03-042	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase I Report.

CTSW-RT-03-053.33.41	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project Phase II Monitoring and Operations Plan. June 2003.
CTSW-RT-03-079.31.37	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase II Report.
CTSW-RT-04-069.04.04	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project Phase III Monitoring and Operations Plan. June 2004.
CTSW-RT-05-069.04.07	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase III Final Report.
CTSW-RT-05-069.04.08	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project Phase IV Monitoring and Operations Plan. January 2005.
CTSW-RT-05-129.05.01	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase IV Report.
CTSW-RT-05-129.05.01	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase IV Report.

3-Year Action Plan

Overview of Approach

The study will continue with fine sand media testing in 4-inch columns. Future experiments may include testing of various loading rates and addition of chemical as a filter aid.

Products or Deliverables

- Reconnaissance study or other literature review reports
- Site-specific Monitoring and Operations Plans
- Final reports summarizing and analyzing data collected

Schedule

Monitoring will likely continue for the next three years. Interim reports will document results of major phases of the study that affect future testing and recommendations for full-scale pilot project.

2.12 TRACTION SAND TRAPS

Traction sand traps capture sand applied to roadways during snowfall events.

2.12.1 Tahoe Basin Pilot Program — Sand Trap with Filter Fabric (TR 1000)

This unit is a double-chambered concrete vault consisting of a sedimentation chamber followed by a secondary chamber with filter-fabric-covered outlets. Larger particles settle in the

sedimentation chamber and smaller particles are captured by the filter fabric before storm water is discharged.

Objectives

These pilots are designed to determine:

- Sand trapping effectiveness
- TSS and turbidity reduction
- Technical feasibility
- Cost

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
SR 267, Lahontan, D-3	2	Water quality monitoring scheduled for 05/06 wet season. Final report anticipated in fall 2008.

Findings/Conclusions

None

Available Documents

Department Document No.	Document Title
CTSW-RT-05-157.01.2	Draft Monitoring and Operations Plan, Caltrans Tahoe Basin Highway 267 Full-Scale BMP Pilot Study Monitoring Season 2005-2006
CTSW-RT-05-157.01.1	Highway 267 Sand Trap With Filter Fabric BMP Pilot Study 2004-2005 Interim Report
CTSW-RT-05-157.01.2	Monitoring and Operations Plan, Caltrans Tahoe Basin Highway 267 Sand Trap With Filter Fabric BMP Pilot Study Monitoring Season 2005-2006

3-Year Action Plan

Overview of Approach

The sampling and analysis plan will be modified each year, as necessary. The sand traps will be monitored for three wet seasons. A final report on cost, performance, and maintenance will be written.

Products and Deliverables

- sampling and analysis plan
- annual monitoring reports
- final report

Schedule
Monitoring will continue in the 05/06 wet season.
The final report will be prepared in FY 07/08.

2.13 VEGETATED TREATMENT SYSTEMS

Vegetated treatment systems are also known as biofilters. Treatment occurs by allowing contact between storm water and the grass. Pollutant removal occurs by contact filtration and infiltration.

2.13.1 Roadside Vegetated Treatment Sites (RVTS) Study

Eight locations throughout California were monitored during the 2001/02 and 2002/03 wet seasons. Data analysis was inconclusive for certain metals because of a lack of events. The effect of design parameters was also uncertain. This study will continue monitoring at the eight locations in an effort to draw stronger conclusions.

Objectives

These pilots are designed to collect data to compare performance:

- to the performance of other approved BMPs, and
- to design parameters.

These comparisons will be used for design guidelines and selection guidelines compared to alternative BMPs.

Current Status

Location (Route, RWQCB, District, Post Mile)	No. of Pilots	Status
Sacramento (I-5, Central Valley, District 3, PM SAC-13.5)	4	Monitoring to begin 2006/07 wet season.
Cottonwood (I-5, Central Valley, District 2, PM SH-1.5)	1	Monitoring to begin 2006/07 wet season.
Redding (SR-299, Central Valley, District 2, PM SH-26)	3	Monitoring to begin 2006/07 wet season.
San Rafael (US-101, San Francisco Bay, District 4, PM MRN-15)	1	Monitoring to begin 2006/07 wet season.
Yorba Linda (SR-91, Orange County, District 12, PM OR-15)	4	Monitoring to begin 2006/07 wet season.

Location (Route, RWQCB, District, Post Mile)	No. of Pilots	Status
Irvine (I-405, Orange County, District 12, PM OR-2.5)	3	Monitoring to begin 2006/07 wet season.
Moreno Valley (SR-60, Los Angeles, District 8, PM RV-14)	4	Monitoring to begin 2006/07 wet season.
San Onofre (I-5, San Diego, District 11, PM SD-70.4)	3	Monitoring to begin 2006/07 wet season.

Findings/Conclusions

For results to date see interim Final Report CTSW-RT-03-028.

Available Documents

Department Document No.	Document Title
CTSW-RT-03-028	Roadside Vegetated Treatment Sites (RVTS) Study. Final Report, November 2003.

3-Year Action Plan

Overview of Report

Collect more performance data.

Statistically compare to design parameters and other treatment BMP performance.

Products and deliverables

Report containing water quality data, visual observations, storm information, site conditions, and a commentary on these observations.

Schedule

FY 2006/2007 monitoring

FY 2007/2008 reporting

2.14 VECTOR STUDIES

Many storm water treatment technologies, or BMPs, are tested to determine performance. Others are modified and tested to see if performance is improved. In its goal to improve BMPs, Caltrans does not want to overlook if these proposed improvements will also provide areas of standing water that may prove to be habitat for mosquito breeding, and thus contribute to impacting public health. BMP Pilot Programs have a concurrent vector component, in which California Department of Health Services (DHS) and the local vector control agency monitor the BMPs to document mosquito breeding. In addition, in an effort to elucidate the relationship between mosquitoes and stormwater BMPs, several research studies were implemented, as discussed below.

Objectives

SR-73 Vector Production Study: Document where habitats for mosquito breeding occur in the ongoing SR-73 BMP Pilot Testing Program for the various pilot systems, and provide suggestions to mitigate these areas. Transform findings into suggested guidelines for Caltrans.

North Lake Tahoe Vector Production Study of Existing Storm Drain Structures and BMPs: Establish relationship between environmental factors (sun exposure, elevation, air temperature, water temperature, etc) and mosquito production at drain inlets, drain inlets with a sump or sand trap, and double barrel traction sand traps. These findings will translate into guidelines for future placement of storm water structures.

South Lake Tahoe Vector Production Study: Compare mosquito production at local BMPs to natural surrounding areas.

Larval Development Study in Tahoe- Determine times for larval development in the Tahoe region, which is typically cooler than other parts of the state. May allow some flexibility in designing BMPs with a longer drain time in the Tahoe region.

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
SR 73, Santa Ana (8), 12 SR 73, San Diego (9), 12	23	Ongoing through 2007.
NLT HW89, Lahontan (6), 3 HW 28, Lahontan(6), 3	22 8	Ongoing, final report due December 2006
SLT HW50, Lahontan, 3	5	Final tech memo pending.
Various locations, Lahontan, 3	5	Final Report due June 30, 2006.

Findings/Conclusions

Ongoing

Available Documents

none

3-Year Action Plan

Products and Deliverables

- South Lake Tahoe Tech Memo
- Larval Development Tech Memo
- North Lake Tahoe Vector Production Final Report
- SR 73 1st Year Report
- SR 73 2nd Year Report
- SR 73 3rd Year Report

Schedule

Monitoring will continue for the next year on the North Lake Tahoe sites, with a final report due December 2006. Monitoring will continue on SR 73, through the end of 2007, maybe more, with interim and final reports documenting each year.

Larval development study will continue through Spring 2007, with the final report due January 2007.

2.15 3-YEAR ACTION PLAN SUMMARY

The 3-year plan for the new and continuing pilots studies are summarized below.

Table 2-1. Summary of 3-Year Schedule for Storm Water Treatment Technology Pilot Studies

Technology	Pilot Program	Location (Route or Facility, RWQCB, District, PM)	No. of Pilots	Scheduled Activities		
				2005/2006	2006/2007	2007/2008
Sand Filters - Partial Sedimentation Austin Sand Filter	District 2 – Austin Sand Filters	I-5 PM 25.07, Central Valley, D-2	1	OM&M	TBD	
Sand Filters - Full Sedimentation Austin Sand Filter	District 2 – Austin Sand Filters	Mt. Shasta Maintenance Station, Central Valley, D-2	1	OM&M		
Various Combinations of Sedimentation, Filtration, Chemical Addition	District 3 - Tahoe Basin Pilot Program	Small-Scale Facility at South Lake Tahoe Maintenance Station	16	OM&M	OM&M	OM&M
Activated Alumina Filters (Dual Media Filters)	District 3 - Tahoe Basin Pilot Program	Hwy 50 (Near Meyers)	2	OM&M	OM&M	TBD
Sand Trap with Filter Fabric	District 3 - Tahoe Basin Pilot Program	SR 267 (Near Brockway Summit)	2	OM&M		
GSRD - V Screen Conf. 2	District 7 - GSRDs	I-405/Leadwall, Los Angeles, D-7, PM 42.6	1	Re-design	Re-construction	OM&M
GSRD - Continuous Deflection Separators	District 11 - CDS	SR-56, San Diego, D-11	2	OM&M	OM&M	OM&M

Technology	Pilot Program	Location (Route or Facility, RWQCB, District, PM)	No. of Pilots	Scheduled Activities		
				2005/2006	2006/2007	2007/2008
GSRD – Linear Radial Steep Slope	District 7 - GSRDs	I-101, PM 17.82	1	OM	OM	
Bioretention	District 12 SR73 Pilot Program	SR 73, Santa Ana, D-12	1	OM&M	OM&M	OM&M
Bioretention	District 4 SFOBB Replacement Project	I-80/ I-880/ I-580/ Toll Plaza, San Francisco, D-4	2	Design	Design	Design
Detention Basins – Bypass	District 12 SR73 Pilot Program	SR73, San Diego and Santa Ana, D-12	4	OM&M	OM&M	
Detention Basins – Overflow	District 12 SR73 Pilot Program	SR73, Santa Ana, D-12	4	OM&M	OM&M	
Detention Basins - Semi-Batch	District 12 SR73 Pilot Program	SR73, San Diego, D-12	4	OM	OM&M	OM&M
Detention Basins - Floating Skimmer Outlet	District 12 SR73 Pilot Program	SR73, San Diego, D-12	3	OM&M	OM&M	OM&M
Detention Basins – Alternative Inlet	District 12 SR73 Pilot Program	SR73, San Diego, D-12	5	1 const./ 4 OM	OM	
GSRD - V Screen Conf. 2	District 12 SR73 Pilot Program	SR-73, Santa Ana, D-12	1	OM&M	OM	

GSRD: Gross Solids Removal Device SR: State Route TBD: To be determined OM&M: Operation, Maintenance and Monitoring PM: Postmile OM: Operational monitoring

This section provides a brief summary and status of erosion control reconnaissance studies and ongoing pilot studies conducted by the Department during the past year.

3.1 PREVIOUS STUDIES

Results from reports completed during last fiscal year (2004/2005) are summarized in Section 3.

Results of erosion control studies completed prior to July 1, 2004 are summarized in the following reports:

- Temporary Non-Vegetative Soil Stabilization Evaluation Study for 2000-01 Season, October 2001, CTSW-RT-01-066
- Caltrans Hydraulic Application Study, June 2002, CTSW-RT-02-035
- Erosion Control New Technology Report, June 2003, CTSW-RT-03-049
- District 7 Erosion Control Pilot Study, June 2000, CTSW-RT-00-012
- Statewide Erosion Control Review, February 2002, CTSW-RT-01-067

3.2 LITERATURE SEARCHES AND RECONNAISSANCE STUDIES

Initial BMP selection is based on information gathered from various sources, including literature searches. Full details on the process of selection and evaluation of erosion control BMPs are given in the Department's Erosion Control New Technology Report, June 2003 (CTSW-RT-03-049). The Department will assess new practices and products with the following possible outcomes: where sufficient information exists, designate a specific practice or product; for promising technologies, commission pilot studies to determine the effectiveness and applicability to conditions at the Department's facilities; or reject practices and products that do not achieve desired results or do not meet the Department's criteria. Erosion control effectiveness is the ability of the BMP to reduce soil erosion relative to the amount of erosion measured from the bare soil.

There were no reconnaissance studies or new technology reports on erosion control performed in the last reporting period.

3.3 ROADSIDE EROSION CONTROL AND MANAGEMENT STUDY (FORMERLY VEMS)

Objectives

The purpose of this project is to identify vegetation, which is both fast establishing and demonstrates long-term effectiveness in preventing erosion using simulated rain to mimic rainfall patterns in various Department Districts. This project also incorporates the development

of a GIS-based guide, which will assist in the selection of vegetative seed species for use in specific areas and climates to increase successful revegetation efforts on highway slopes. A guide has been established for the Department, District 5, representing the California Central Coast. Future plans include generating guides for remaining Districts to assist in the selection of vegetation for roadside stabilization.

Status

Location (Route, RWQCB, District)	No. of Pilots	Status
California Coast, D-5, Cal Poly Campus	1	Testing ongoing.

Findings/Conclusions

A report presenting the interim results is complete. Preliminary results indicate vegetation flats on the top and toe performed the best by reducing runoff by 80 percent and sediment load by 99 percent when compared to no treatment. Hydroseeding alone produced the most overstory cover while seeding on compost produced the most understory cover. There is a much stronger relationship between increased understory cover and sediment reduction, versus increased overstory cover and sediment reduction. Flats on the top and toe with hydroseeding alone produced the most total vegetative cover. Jute with seed on compost yielded significantly less total runoff and jute with seed or compost removed significantly more sediment from runoff than other erosion control treatments. Jute inhibited desirable vegetation when compared to applications with no erosion control treatment. 5.08 cm (2-inch) of compost inhibited undesirable cover, and inhibited desirable cover if seeded beneath the compost. Flats on the top and toe, when combined with jute netting and hydroseeding applied mid-slope, should perform the best for encouraging native plant establishment and minimizing soil erosion. A paper based on the results of this study received the "Most Distinguished Technical Paper Award" for 2004 by the International Erosion Control Association.

Available Documents

Department Document No.	Document Title
CTSW-RT-02-052	Rainfall Simulation: Evaluating Hydroseeding and Plug Planting Technologies for Erosion Control and Improved Water Quality, September 2002
CTSW-RT-04-069.06.1	Performance of Erosion Control Treatments on Reapplied Topsoil
CTSW-RT-05-069.06.2	Native Shrub Germination Relative to Compost Type, Application Method, and Layer Depth

3-Year Action Plan

Purpose

The Seed Mix and Vegetation Establishment Summary is a continuation of the VEMS. The purpose is to develop guidance for effective establishment and maintenance of erosion control vegetation for short-term first growth and for long-term establishment. The vegetation examined in this study will include both native and non-native species. The Department will use the results of this study in an effort to decrease erosion and thereby improve water quality. There is a need to address both vegetation establishment and regular maintenance needs, including time of year for planting, plant selection, soil stabilization, and vegetation needs throughout the lifecycle. Performance criteria include stabilization within 30 days and mature, stable vegetation in one to three years.

Overview of Approach

Tasks in this study include:

1. Run Preliminary Testing: Using the Department's District 5 parameters, run rainfall simulations to develop baseline conditions, update District 5 model and expand to other districts.
2. Develop Plan for Statewide Testing: Apply baseline findings to develop testing strategy for vegetation establishment in other Department Districts
3. Final Report: Summarizing and evaluating data collected at each site

Product or Deliverables

- Draft Report
- Final Report

Schedule

FY 2005-2006	Develop District Level Guidelines for the Department's other Districts as appropriate. Conduct monitoring, and document activities and results in post-storm technical memoranda.
FY 2006-2007	Prepare Final Report.

3.4 SOIL RESOURCE EVALUATION PROCESS (ONGOING)

Objectives

This study creates a site evaluation tool that will present revegetation recommendations for large projects. The tool will assist landscape architects, civil engineers, and material engineers in assessing soil characteristics that affect revegetation. The tool guides the user through a seven step process to evaluate a project site. The tool will generate revegetation recommendations based on the information from other erosion control studies. This study considers how information from past studies can improve site evaluations to allow better recommendations for revegetation. The user inputs site characteristics that may affect revegetation success. Based on the input, the tool will offer several options that may correct deficiencies for plant establishment. The tool is expected to have statewide applicability for projects large enough and harsh enough to benefit from a more thorough and systematic evaluation. Examples of successful treatments are expected to be applicable to many other future construction sites, even without site-specific evaluation.

The tool will specifically use information from the study Use of Organic Amendments for Revegetation of Disturbed Sites with Adverse Soil (ongoing see Section 3.6). The end product is a flow chart of assessment steps and a CD that contains the program that gives revegetation recommendations.

Status

Location (Route, RWQCB, District)	No. of Pilots	Status
HWY 101, near Willits, Mendocino Co., D-1	1	Complete.
HWY 299, Buckhorn summit, Shasta Co., D-2	1	Complete.
I-80, near Blue Canyon, Placer Co., D-3	1	Complete.

Phase I complete. Phase II starting 2005/2006. See 3 Year Action Plan.

Findings/Conclusions

This project is ongoing.

Available Documents

Document Location	Document Title
http://www.dot.ca.gov/hq/LandArch/research.htm	Soil Resource Evaluation Process (Expert Tool)

3-Year Action Plan

Product or Deliverables

The following comprise the deliverables for this study:

- One page flow chart linked to an interactive CD, and add more data.
- Develop and Perform related training for the end users (Phase I complete, Phase II training ongoing)
- Final Report

Schedule

FY 2004-2005	continue tool development and update/add information.
FY 2005-2006	continue tool development and update/add information.
FY 2006-2007	continue tool development and update/add information.
FY 2007-2008	complete deliverable

3.5 USE OF MYCORRHIZAL FUNGI IN EROSION CONTROL APPLICATIONS (ONGOING)

Objectives

This study investigates the relationship of plant species used for revegetation with mycorrhizal fungi. These are soil-dwelling fungi that occur naturally, and form symbiotic relationships with plant roots. The fungus provides improved plant access to nutrients, and this symbiosis enhances the survival of both plant and fungus. The benefits to native plants are of particular interest. Although the fungus occurs naturally in native soils, it is largely absent in highway embankments or cut slopes. Commercial products containing live fungal propagules are available to support revegetation efforts. The project consists of greenhouse plot experiments and field trials in Irvine under natural climate conditions. The study is expected to have statewide applicability.

Status

Location (Route, RWQCB, District)	**No. of Pilots**	**Status**
UC Irvine	1	Complete
District 4, Devils Slide	1	Data collection

Findings/Conclusions

Study is complete. Final Report is in peer review. Results show that native plants are more dependent than exotic plants on the mycorrhizal relationship, and this dependence is expected to boost native plant establishment. The plot results show that native plant material has the ability to out-compete the exotic species when sufficient fungi are present. Moreover, the interaction between mycorrhizal fungi and native plants can improve soil stability more than the interaction of these fungi with exotic species.

Available Documents

Document Location	Document Title
http://www.dot.ca.gov/hq/LandArch/research.htm	The Use of Mycorrhizal Fungi in Erosion Control Applications

3-Year Action Plan

Product or Deliverables

Pilot project will determine how to apply fungi using: hydraulic methods, stock piling, etc.

Final Report

Schedule

FY 2005/20006 data collection

FY 2006/2007 data collection

FY 2007/2008 reporting

3.6 THE USE OF ORGANIC AMENDMENTS FOR RE-VEGETATION OF DISTURBED SITES WITH ADVERSE SOILS

Objectives

This study evaluates the use of organic amendments for disturbed sites that are difficult to revegetate. Difficult sites specifically addressed are those with serpentine and granitic soils. The primary method evaluated in the study is mixing urban green waste into the soil. Finite plant material is also being investigated. Finite plant materials are very site specific native plants that only grow on certain types of soil. Some of these plants may successfully revegetate adverse soils. Finite material may be useful for sites where organic amendments are not feasible. The study is expected to have statewide applicability.

Status

Location (Route, RWQCB, District)	No. of Pilots	Status
HWY 20, Colusa Co.	1	Reporting
HWY 299, Shasta Co.	1	Reporting

Findings/Conclusions

Work is ongoing. Preliminary results show that organic compost can increase revegetation success for drastically disturbed sites where current plant establishment techniques would be unsuccessful. Incorporation of coarse (unscreened) yard waste compost onto erosive, decomposed granite slopes increased infiltration and plant available moisture up to levels of stable, revegetated reference samples. These methods were incorporated into a subsequent project to rebuild the rest of the eroding slope at the highway 299 site. The information from this study is being used in the soil resource evaluation project.

Available Documents

Final report is expected in 2006.

3-Year Action Plan

Product or Deliverables

Final Report

Schedule

FY 2005-2006 Prepare final report.

3.7 PILOTING SOIL STABILIZATION: PERMANENT

Objectives

Purpose

The purpose is to evaluate the performance of non-vegetative permanent soil stabilizers for reducing soil erosion, and the potential impact of these products on storm water quality. The Department has identified the need to assess the potential impact of permanent erosion control measures upon storm water quality. Although numerous products exist for use, the technologies have not necessarily been analyzed, by the manufacturer, for constituent (including sediment) release into storm water. The study is designed to identify, and quantify (if possible) the effect of permanent erosion control materials on storm water.

Examples of products to be identified are:

- Acrylic polymer soil stabilizers
- Soil stabilizing polymer emulsions
- Rock Blanket application (geotextile under a layer of rock obtained from local sources)
- UV-stabilized blankets
- Resin-based soil stabilizers
- Concrete block systems
- Soil cement applications (a native soil and cement mixture)

Overview of Approach

Activities associated with this task will include siting of study sites, construction of test plots within each study site, application of a selected erosion control product to each test plot, and installation of sampling equipment to monitoring storm water runoff from each plot. The monitoring effort will evaluate the potential impact (if any) tested products have on storm water quality.

3-Year Action Plan

Product or Deliverables

- Data collection
- Final Report summarizing and evaluating data collected at each site

Schedule

FY 2005-2006	Conduct monitoring and document results.
FY 2006-2007	Conduct monitoring and document results.
FY 2007-2008	Prepare Final Report

3.8 3-YEAR ACTION PLAN SUMMARY

Table 3-1. Summary of 3-Year Schedule for Erosion Control Studies

Erosion Control Study	Location (Route or Facility, RWQCB, District)	No. of Pilots	Scheduled Activities		
			2005/2006	2006/2007	2007/2008
Roadside Erosion Control and Management Study (formerly VEMS)	California Coast, D-5	1	Monitoring	Reporting	N/A
Soil Resource Evaluation Process	Various Locations	3	Monitoring	TBD	TBD
Mycorrhizal Fungi in Erosion Control Applications	Irvine	1	Monitoring	Monitoring	Reporting
Organic Amendments for Re-vegetation of Disturbed Sites with Adverse Soils	Various Locations	2	Reporting	TBD	N/A
Piloting Soil Stabilization Permanent	TBD	TBD	Monitoring	Monitoring	Reporting

This section provides a brief summary and status of characterization studies that were completed or ongoing during 2003/2004.

4.1 PREVIOUS STUDIES

Results from reports completed during last fiscal year (2004/2005) are summarized in Section 4.

Results of storm water characterization studies completed by the Department prior to July 1, 2004, are contained in the following reports:

- Discharge Characterization Study Report, CTSW-RT-03-066.51.42
- Caltrans Tahoe Highway Runoff Characterization and Sand Trap Effectiveness Studies, 2002-2003, June 2003, CTSW-RT-03-054.36.02
- Monitoring Report 2000-2001: Caltrans Public Education Litter Monitoring Study, June 2001, CTSW-RT-01-018
- Small Stream Crossing Impact Research Project, North Coast River Loading Project, CTSW-RT-02-040
- Caltrans Construction Site Runoff Characterization Study, September 2002, CTSW-RT-02-055
- Caltrans Drain Inlet Efficacy Study (DICE) Final Report, June 2003, CTSW-RT-03-057.36.1
- Evaluation of Factors Controlling Herbicide Runoff to Surface Water, May 2005, CTSW-RT-03-084.73.04

For each study in this section, reports are listed that should be consulted for additional details. For those studies that are ongoing, a 3-Year Action Plan is provided that addresses tasks and approaches, products or deliverables, and schedules:

4.2 STATEWIDE TOXICITY TESTING STUDY

Objectives

The goal of the Statewide Toxicity Testing Research Project is to enable the Department to assess the toxicity associated with discharges from its storm drain system, determine the cause of the toxicity, and provide some understanding of the sources of these discharges.

Current Status

Completed.

Findings/Conclusions

The results obtained from the 2000-01 and 2001-02 wet seasons are summarized below. Toxicity was monitored at four categories of sites; highway drains, maintenance yards, park and ride facilities, and rest areas. In the year 2000-01, 24 highway sites were monitored requiring 278 toxicity tests, four maintenance yards were monitored requiring 65 toxicity tests, 8 park and ride facilities requiring 106 tests, and three rest areas requiring 19 tests (total 39 sites and 465 tests). Of the 39 sites, 23 sites indicated significant acute toxicity. TIEs were performed for 23 sites, requiring an additional 190 toxicity tests.

Each site was tested from one to four times throughout the season resulting in a total of 98 samples tested for toxicity. At least one toxicity test at one sample period (early, mid, and late winter) was significantly different from the control (indicating toxicity) at all but 2 sites. Conversely, 5 sites had dates with no toxicity for any test. Of the three types of toxicity test, the *Pimephales* test resulted in the greatest number of positive test results (significant toxicity) while the *Selenastrum* (algae) resulted in the least number of positive results.

Pimephales – Of the 98 tests performed, 82 (83.7%) indicated significant toxicity for either one or both tests. Significant reductions in biomass were found in 52 samples, and significant mortality was found in 28 samples indicating that most often, reductions in biomass were common and acute toxicity was less common. No pattern in toxicity with respect to date of sampling is apparent as significant toxicity was found at all dates from October to May.

Ceriodaphnia – Of the 98 tests performed, 72 (73.5%) indicated significant toxicity. These results include all tests for which acute toxicity occurred and chronic tests were not possible to perform. As with the *Pimephales* toxicity test results, there appears to be no pattern with respect to date of sampling as significant toxicity was found throughout the entire period of sampling.

Selenastrum – Of the 98 tests performed, 46 (46.9%) indicated significant toxicity. The *Selenastrum* test was never the sole positive test result for any site at any sample date. Again, no pattern in the positive results was evident.

Toxicity Identification Evaluations (TIEs) – Thirty TIEs were performed on samples for which acute toxicity was observed. The TIEs indicated that no single source of toxicity was common among sites. However, nonpolar organic compounds were suggested as the putative source of toxicity in 5 of the TIEs, metals were suggested as the putative source in 11 TIEs, and surfactants were suggested as the putative cause in 7 cases. In one case, a metabolically active pesticide was implicated, and the remainder had no discernable cause.

The results were consistent across years with the samples collected during the 2001-02 exhibiting a slightly higher percentage of toxic samples. In general, the results from the *Pimephales* tests were almost identical in the overall percentage, and the *Ceriodaphnia* tests during 2001-02 produced a slightly higher percentage of tests with toxicity. The greatest difference is in the results of the *Selenastrum* tests performed in both years. Only a small

number of samples were determined to be toxic by the *Selanastrum* test during 2000-01, but almost half of the tests resulted in significant toxicity during 2001-02.

Available Documents

Department Document No.	Document Title
CTSW-RT-05-073.10.1	Toxicity of Storm Water from Caltrans Facilities

4.3 CALIFORNIA TOXICS RULE (CTR) CHARACTERIZATION STUDY

Objectives

In Spring of 2000, the US Environmental Protection Agency promulgated new ambient water quality criteria for California known as the California Toxics Rule (CTR). Numerical standards were established for 100 constituents, many of which have not been previously studied in highway runoff. Objectives for this project, being conducted by the University of California, Davis, include (1) developing cost effective sampling and analytical strategies to attain the low detection limits required under the CTR, (2) identifying constituents that exceed the CTR limits in runoff from Department facilities, (3) engineering mitigation strategies for problematic compounds

Current Status

The final report is under preparation.

Findings/Conclusions

Principal findings of the CTR study are summarized below:

Inorganics: All species were detectable with our techniques, and based on their concentrations, metals can be classified into three groups: far below all criteria, of possible concern, and definitely having exceedances. First, dissolved concentrations of Be, Cd, Hg, Ag and Tl were very low and always far below all CTR criteria. Arsenic (As), Chromium (Cr) and Lead (Pb) were found at moderate concentrations but never exceeding a CTR limit. (Moreover, Cr was sufficiently low that no exceedance for the hexavalent form was possible.) However, Nickel (Ni), Copper (Cu) and Zinc (Zn) were consistently found at substantial levels. They surpassed the CTR continuous limit (and sometimes the acute maximum criterion) either in some (Ni), most (Zn) or all (Cu) of the storm water runoff samples. The higher maintenance yard Zn concentrations presumably arise from the abundant zinc-coated (galvanized) materials stored there. Data from the second year are similar.

Cyanide measurements exceeded the lowest CTR standard, for discharges to saltwater, in some samples. Investigations of these observations continue to rule out any possible interferences. Also, asbestos fibers are definitely not of concern for highway run-off.

In addition, it seems that total suspended solids (TSS) and dissolved organic carbon (DOC) are important factors in controlling the concentrations of dissolved metals in storm water runoff. There was a significant correlation between the concentrations of dissolved metals and TSS, indicating that TSS in storm water runoff was an important source of metals in dissolved form. Also there was a strong correlation between the concentrations of dissolved metals and DOC, suggesting the importance of DOC in complexing metals and making them more mobile in storm water runoff. Further analyses continues for un-filtered samples.

Organics: It is convenient to summarize the situation by chemical classes of analytes, even though the CTR list itself is not generally organized by type of compound.

Detectable concentrations of volatile organic compounds (VOCs) were found, in some cases relatively close to those CTR criteria where the latter are exceedingly low, such as 1,1,2,2-tetrachloroethylene. In these cases, the ability to produce a very low field blank is the limitation. Benzene, a molecule of heightened awareness, reached a high of only ¼ of the lowest criterion.

For several classes of semi-volatile compounds, concentrations were seen above at least one CTR criterion. In the phenol group, pentachlorophenol was detected consistently at both sites at levels slightly exceeding the lowest CTR limit.

Among organo-chlorine compounds, lindane and heptachlor were detected above CTR limits at the maintenance yard for several events. In addition, 3 legacy insecticides were sometimes found in highway run-off above a criterion: DDT/DDE, chlordane and beta-endosulfan (the latter, only once so far).

A few polycyclic aromatic hydrocarbons (PAHs) were found to exceed criteria at least once in the highway runoff: benz[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[a]pyrene, indeno[1,2,3-cd]pyrene, and dibenzo(a,h)anthracene

Five phthalate compounds are listed in CTR. One (diethylhexyl, or DEHP) has quite a challengingly low criterion. Another, butylbenzyl, was seen nearly up to the lowest criterion for a few storms.

It was noteworthy that some of the highest concentrations observed were during or after the middle of winter – for example following a multi-week period without storms, and from the run-off of a smaller event that provides less dilution. The total mass loading from small storm events is probably not higher than larger storms, because small storms correspond to smaller total volumes of runoff. Second-year results were flow-weighted to improve these estimates.

Available Documents

The Final Report is under preparation. Final Report expected in FY 2005/2006.

3-Year Action Plan

Tasks/Approach

Prepare final report, incorporating comments from report reviews.

Product or Deliverables

Final Reports

Schedule

FY 2005-2006 Final report

4.4 FIRST FLUSH CHARACTERIZATION STUDY

Objectives

The goal of this study is to identify constituent concentration variability with relation to storm intensity, duration and antecedent weather patterns. The data collected will be used to develop pollutographs and, potentially, to design BMPs to remove large fraction of pollutant mass load within a smaller drainage areas. Information on the spatial and temporal distribution of contaminant concentrations in storm water runoff is lacking. Of particular importance is the relationship between the periodic dry season deposition of contaminants, storm intensity and duration, and the contaminant concentrations in storm water runoff.

Current Status

Complete.

Findings/Conclusions

1. Most of the water quality parameters associated with highway runoff show a first flush with 20 to 50 percent of the pollutant mass in the first 10 to 30 percent of the runoff.

2. Preliminary particle measurements show that 97 percent of the particles are smaller than 30 mm.

3. The particles tend to aggregate with time, suggesting a natural coagulation/flocculation phenomena.

4. Comparison of the computed EMC from grab samples, as part of the first flush characterization study, with the EMC of automatic composite sample confirmed the suitability of automatic sampler for collecting a representative runoff samples.

Available Documents

Department Document No.	Document Title
CTSW-RT-99-074	Caltrans First Flush Study Sampling and Analysis Plan, November 1999
CTSW-RT-00-016	First Flush Study 1999-00 Report, June 2000
CTSW-RT-00-044	Sampling & Analysis Plan, Caltrans 2000-01, First Flush Characterization Study, December 2000
CTSW-RT-01-037	Summary Report Caltrans 2000-01 First Flush Characterization Study, July 2001
CTSW-RT-00-044U	Sampling & Analysis Plan, Caltrans 2000-01, First Flush Characterization Study, October 2001
CTSW-RT-03-064.73.02	First Flush Stormwater Runoff Characterization Study

4.5 PATHOGENS CHARACTERIZATION STUDY

Objectives

A sensitive method for the detection of pathogens in environmental water has been developed, using *Salmonella enterica serovar typhimurium* as a model organism. The method involves the hybridization in solution of target DNA with biotin-labelled capture probes, followed by binding the hybrid to streptavidin-coated magnetic beads. The high affinity between streptavidin and biotin makes this specific binding possible. The application of a magnetic field to this complex permits the separation of target DNA from a complicated matrix that may contain PCR inhibitors and non-target DNA, thus increasing the sensitivity of the assays and decreasing the detection limits. The detection and quantification of the DNA was performed by real-time PCR. Since the recovery of target DNA using the beads was around 50 percent, a statistical procedure was used to calculate the actual pathogen concentration in the original sample from the measured values.

Since pathogens associated with storm water discharge may be present in low concentrations, an effective filtration step is necessary. Previous work with adsorptive filters revealed poor recoveries of virus in storm water. Other researchers have had similar difficulties when using such electrostatic charged filters. An extensive literature review of filtration methodologies showed that filtration based on size exclusion seemed to be less susceptible to interfering compounds. A hollow fiber unit (tangential filtration flow) was selected, which according to

other researchers result in consistent recoveries in the range of 70-80 percent when applied to complex water samples.

This work requires sampling in various geographical locations in California, so a portable filtration apparatus is needed. Such a design will enable the filtration and concentration on site of large volumes (up to 100 liters) of water that will be preserved and analyzed back in the laboratory. A first design of the process unit and its quotation were evaluated, and because of the high cost resulted in a second design that led to the apparatus currently being built.

Human adenovirus and enterovirus are two epidemiologically important viruses associated with water that has been contaminated by human waste. Previous studies have demonstrated that these two virus groups may be more prevalent in storm water, or may simply persist longer in the environment. The quantitative detection of these viruses will be done using real-time PCR, and reverse-transcription (RT) PCR. Specific primers and probes for the amplification of both viruses are currently being developed. The design of primers and optimization of the PCR reactions are crucial to the success of the assay.

Since the viruses will be concentrated from large volumes of water, it is critical to determine the efficiency of filtration for each sample. This is accomplished by spiking a known amount of a benign surrogate virus into the water. For this study, the bacteriophage PP7 was selected because of its similar behavior to human enteroviruses during hollow-fiber filtration. Inclusion of this virus in the assay also requires the design of proper probes and primers for quantitative PCR detection and the optimization of the reaction. To have an accurate measure of virus recovery, PP7 viral particles will be enumerated using PCR, rather than traditional culture-based plaque assays. The PP7 viral particles are quantified by first synthesizing cDNA from the RNA. The cDNA is subjected to quantitative PCR, and the amplification products then cloned into plasmid DNA that is quantified again by PCR. This process of cloning nucleic acid and quantification is also being done for adenovirus and enterovirus.

In addition to the above viruses, bacterial indicators (total coliform and fecal coliform) and the intestinal organism *Escherichia coli* will be monitored using the membrane filtration method according to EPA's *Guidelines Establishing Test Procedures for the Analysis of Pollutants; Analytical Methods for Biological Pollutants in Ambient Water; Final Rule* (July 2003). Training and preliminary preparations are under way to complete these tests by graduate students at the university.

Current Status

Reporting.

Findings/Conclusions

Results obtained to date from this study are summarized below:

- The detection of *Salmonella enterica* serovar *typhimurium* with the method developed was successful.
- The principle of the method may be extended to any bacterial, protozoal, or viral pathogen of interest by designing the appropriate probes and primers and optimizing reaction conditions.
- Specific probes and primers for quantitative PCR detection of PP7 were designed and the amplification reaction was optimized. The first Taqman assays were successful for both RNA and cDNA.
- This study does not address the ability of treatment BMPs to reduce pathogens.

Available Documents

Department Document No.	Document Title
CTSW-RT-02-025	Pathogens in Urban Drainage: Results of Investigations of the Presence of Human Pathogens in Urban Storm Drains, March 2002.

3-Year Action Plan

Tasks/Approach

Prepare draft and final report

Product or Deliverables

Draft and final reports summarizing analytical procedures and all test results.

Schedule

FY 2005-2006 Prepare Final Report

FY 2006-2007 TBD

4.6 DISTRICT 7 DRAIN INLET CLEANING EFFICACY STUDY (LITTER ONLY)

Objectives

The goal of this project is to determine whether drain inlet cleaning impacts the water quality of storm water runoff from the Department's highways. Both water quality and litter were monitored as part of this study. Sufficient water quality data were obtained for over four years and a comprehensive report was prepared on this topic. Litter, however, was monitored for only one year. It is planned to monitor litter at DICE sites during the 2004/05 wet season. The Final Report does not include this final phase of litter monitoring. The report reference is CTSW-RT-03-057.36.1.

Current Status

Reporting.

Findings/Conclusions

The results indicate that there was no significant change on water quality among those sites that were cleaned compared to those that no cleaning was performed. A statistically significant difference in litter volume was not observed. This was not the case for litter mass.

Available Documents

Department Document No.	Document Title
CTSW-RT-03-057.36.1	Drain Inlet Cleaning Efficacy Study, June 2003

3-Year Action Plan

Tasks/Approach

Prepare Final Report

Product or Deliverables

Final reports.

Schedule

FY 2005-2006 Prepare final report.

4.7 3-YEAR ACTION PLAN SUMMARY

The 3-year plan for the new and continuing pilots studies are summarized below.

Study	**Location (Route or Facility, RWQCB, District)**	**Scheduled Activities**		
		2005/2006	**2006/2007**	**2007/2008**
California Toxics Rule Characterization Study	Various	Reporting		
Pathogens Characterization Study	UC Davis	Reporting		
District 7 Drain Inlet Cleaning Efficacy Study	8 freeway locations in District 7, Los Angeles	Reporting		

Caltrans, 1999. National Pollutant Discharge Elimination System (NPDES) Permit for Storm Water Discharge from the State of California, Department of Transportation (Caltrans) on Properties, Facilities and Activities.

Caltrans, 2003. Statewide Storm Water Management Plan. May 2003. CTSW-RT-03-008

APPENDIX A *Monitoring Protocols and Tools*

Over the last several years the Department has implemented an impressively diverse and intensive storm water monitoring program. Much effort has been invested into ensuring that the monitoring data produced by the Department's storm water monitoring program will be scientifically defensible. As a result the Department has developed the following manuals and software tools:

- Comprehensive Monitoring Protocols Guidance Manual
- Data Reporting Protocols
- Automated Data Validation (ADV) and Laboratory EDD Error Checker
- Hydrologic software utility
- Data analysis tool
- Master Stormwater Database

The above manuals and software tools are available through an electronic tool box (CTSW-OT-03-002) and mandated its use by all monitoring teams collecting data. The application of each manual and software tool is briefly described below.

Comprehensive Monitoring Protocols Guidance Manual

This Comprehensive Manual is a compendium of individual Guidance Manuals covering each of the four types of monitoring conducted under the Department's Storm Water Monitoring and Research Program: Stormwater Runoff Water Quality Monitoring, Particle/Sediment Quality Monitoring, Litter Monitoring, and Toxicity Studies.

A technical committee was established to guide production of each of the individual subject area Guidance Manuals, led by experts experienced in the field. The principal aims of the Guidance Manuals are to:

- Ensure consistency in monitoring methods throughout the state
- Specify scientifically-sound sampling and analytical techniques
- Minimize contamination of environmental samples
- Produce data of verified quality

The *Guidance Manual: Stormwater Monitoring Protocols* (Caltrans, 2000), which contains the runoff water quality protocols, is available on the Department's Storm Water Management Program web site: http://www.dot.ca.gov/hq/env/stormwater/special/newsetup/index.htm

Data Reporting Protocols

To ensure informality, the Department has established data reporting protocols in Excel format. Entries into data fields were standardized for both analytical and non-analytical data. The data reporting protocol provides detailed specifications for data fields and instructions for content. The protocols help ensure that data from all projects will be reported in consistent format – and that the data records will include sufficient information to permit their full use within the Department's Storm Water Database. Once Excel spreadsheets are reported to the Department according to data reporting protocols, data are imported into an access database that holds statewide monitoring data. These data are extracted for statistical analysis and data evaluation.

Automated Data Validation (ADV) software

A thorough data quality evaluation is performed following receipt of the laboratory data, in which the results of QA/QC sample analyses are compared to the project's data quality objectives, and suspect data are qualified (flagged) as necessary, following guidelines established by the United States Environmental Protection Agency (EPA) for evaluation of inorganic and organic analyses.

The automated program permits quick and efficient evaluation of lab data against data quality objectives and standard measures of data quality, and provides extensive error-checking for a standard set of possible analytical or data transcription errors. The resulting electronic data deliverable (EDD) is then ready for final checking prior to entry into the Department's storm water quality database. The final data validation step involves checking that the EDD conforms to the Department's Data Reporting Protocols for the specific data type; corrections are made as necessary to provide information for any missing or improperly-populated data fields.

Hydrologic software utility

This software assists monitoring managers in determining whether the sample representativeness criteria have been met for a given monitoring event. The purpose of the Department's Hydrologic Utility is to standardize consultant calculation of important storm and sampling parameters, such as total flow volume, total event rain, estimated percent capture, and others. In addition, the utility generates a hydrograph and a hyetograph from measured hydrologic data.

The hydrologic utility is installed as an "Add In" in Microsoft Excel and is composed of a number of Visual Basic subroutines. The calculations and graphs are created from user-controlled input parameters as well as datalogger exports of rainfall, flow rate, and sample data records. The utility output is in two parts; a new worksheet and a new plot (chart) are added to the workbook. The output worksheet contains the processed input data that acts as the source data for the plot and a summary table of important calculations. The output hydrograph and hyetograph plot notes the timing of the primary composite sample aliquots, when they are provided, and includes a table of important summary data. The plot and the calculated parameters are output to a worksheet page that can be printed and added to event reports. An example of the hydrologic utility output is shown on the following page.

Data Analysis Software Tool

The Department has developed a software tool as a means to efficiently generate descriptive statistics for monitoring data. The DAT can be run on user-selected data sets directly from the database interface screen, or used as a stand-alone Excel Add-In. The DAT employs a Regression on Order Statistics (ROS) technique for appropriate statistical treatment, including handling of non-detect data. This tool uses the detected values and a combination of regression and probability analysis to determine a "fill-in" concentration value to assign to all data points below the reporting limit (non-detects), based upon an assumed log-normal probability

distribution The filled-in values are then used in statistical analysis. An example of the output from the DAT is shown on the following page.

Master Stormwater Database

Once the error-checking and data validation process is complete, EDDs (in the form of Excel spreadsheets) are delivered to the Department, and the data is imported into an Access database. Data are stored in three main tables: sample description, event description, and site description. The fields and content guidelines for each of these tables are described in the Data Reporting Protocols for each category of data (runoff water quality, particle/sediment, litter, toxicity). The Department's Storm Water Quality Database includes a user-friendly interface with a GIS-based map feature and menu-driven query screen. This interface permits quick and easy retrieval of data based on user-selected parameters. A screen shot from this data management tool is shown below.